DAIMLERCHRYSLER

DaimlerChrysler Corporation
Stephan J. Speth

Director
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July 2, 2004

Mr. Stephen R. Kratzke
Associate Administrator for Rulemaking
National Highway Traffic Safety Administration
U.S. Department of Transportation
400 Seventh Street, S.W.
Washington, DC 20590

Re: Request for Comments
FMVSS 208 – Occupant Crash Protection
Docket No. NHTSA-2003-15715

Dear Mr. Kratzke:

DaimlerChrysler Corporation and Mercedes-Benz USA, LLC (hereinafter jointly referred to as DaimlerChrysler) submit the following comments on the referenced notice published in the Federal Register on February 3, 2004 (69 FR 5108). The notice seeks comment on the merit of adding a higher speed offset deformable barrier impact test to FMVSS 208 – Occupant Crash Protection. The objective of this additional test would be to address the occurrence of lower extremity injuries seen in the field.

DaimlerChrysler applauds the agency's decision to allow an additional 90 days to respond to this request for comments. We believe it was important to allow all interested parties the additional time in order to analyze the cost benefit analysis placed into the docket. However after careful review of all docketed information, DaimlerChrysler believes that additional studies should be undertaken before additional rulemaking actions are initiated. Our concerns are addressed in the attached answers to the ten specific questions asked by the agency in the notice.

In addition, DaimlerChrysler participated in the development of the comments submitted by the Alliance of Automobile Manufacturers (Alliance) and fully endorses that organization's document. We believe the Alliance's position that any additional requirements to the standard must be driven by the science and knowledge pertaining to the source of the problem is the prudent course of action. The work plan outlined by the Alliance will allow the formulation of a vehicle crash test that should provide the best methodology for reducing the frequency and severity of lower extremity injuries that occur in the field.

As always, DaimlerChrysler would be pleased to discuss the content of this response with the agency should clarification be necessary. Feel free to contact Mr. Ian Palmer of my staff at (313) 493-3425 should you have any further questions.

Sincerely,

S. J. Speth

S. J. Speth
Director, Vehicle Compliance and Safety Affairs

Attachment

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DaimlerChrysler Response

**Request for Comments - High Speed Offset Deformable Barrier Test
(Docket No. NHTSA-2003-15715)**

General position:

- DaimlerChrysler has several years of experience with the offset deformable barrier test and the instrumented lower leg device [1-6]. DaimlerChrysler supports NHTSA's consideration of the offset deformable barrier test to reduce lower extremity injury and to optimize car-crash performance towards real world crash scenarios.
- DaimlerChrysler, however, supports an offset deformable barrier test conducted at mass-dependent speeds with a maximum speed of 56 km/h (or 60 km/h depending upon the mass of the considered reference small car) and a mass restriction of 2,500 kg in order to balance self-protection and partner-protection.
- An attempt to address potential neck concerns associated with small occupants (belted and unbelted) is included in the current FMVSS No. 208, although we continue to believe there is a lack of biofidelity of the Hybrid III ATD neck and, thus, inadequate justification for using Nij as an assessment quantity. DaimlerChrysler does not see any additional benefit in further attempts to address potential neck injuries associated with small occupants through a high-speed offset deformable barrier test.
- DaimlerChrysler supports the use of both Hybrid III Denton leg and Thor-Lx Hybrid III retrofit leg as alternative test devices with equivalent assessment quantities over a period of time [7]. A decision to use one of the two test devices can then be made objectively.
- As an alternative to the offset deformable barrier test, inclusion of the instrumented lower leg device in the rigid barrier test (40 km/h) of the current FMVSS No. 208 could be considered.
- As noted in the Alliance response, DaimlerChrysler believes any additional test incorporated into FMVSS 208 needs to be driven by the understanding of the injury causation for vehicles that reflect designs on the road today.

1. Are NHTSA's anticipated safety benefits associated from a fixed offset deformable barrier crash test requirements provided in Section IV realistic? Please provide data to support any views.

Based on NASS/CDS data from 1995-2001, the agency has submitted to the docket a brief analysis of the lower extremity injury benefits of the ODB test. According to the agency's submission, 16% of the front outboard occupants suffer MAIS 2+ lower extremity injuries annually. Further, based on available test data, the agency estimated injury benefits from ODB tests at different speeds as well as from a MDB test. The agency included estimates for the Denton device as well as the Thor Lx. The agency's submission indicates that the test data available were not uniform. For example, in the case of MDB tests, no results for Thor Lx were available. In ODB tests at 64 km/h, results of 47 tests were available for the Denton device against only 2 tests for the Thor Lx. In the 56 km/h ODB test, no results for the Denton device were available. In general, except for the 64 km/h ODB tests conducted by IIHS using a 50^{th} % male Denton device, the data are limited to 7 tests or fewer per condition.

The agency indicated that it estimated the lower benefit bounds based on the measurements made with the 50^{th} % male Denton device in IIHS tests (64 km/h). The agency estimated the upper benefit bounds based on the unbelted 5^{th} % female for which data were not available. The agency attempted to address this deficiency by assuming that the benefits to unbelted 5^{th} % females would be the same as the benefits to the belted 50^{th} % males. The agency distinguished between the estimates for the Denton and the Thor Lx devices based on the consideration that the latter would include additional benefits to calcaneus and foot/ankle injuries.

We believe the analysis submitted by the agency is based on limited (insufficient) data. Moreover, the explanation presented by the agency does not enable us to understand the rationale behind the agency's annual reduction estimate of 1,300 to 8,000 in MAIS 2+ lower extremity injuries. Finally, the agency mentioned in its docket submission that "All estimates did not consider potential disbenefits from increased stiffness of vehicles" reinforcing our position that the analysis is incomplete.

In our opinion, the agency's benefits analysis could be improved by obtaining additional test data and by including projections of benefits and disbenefits to other body regions. In particular, potential disbenefits to unbelted occupants, due to stiffening of vehicles such as SUVs and trucks for the high-speed ODB test, need to be taken into account before the impact of the high-speed ODB test can realistically be estimated.

2. **In addition to potential disbenefits to the occupants of collision partners described in this notice, are there other potential disbenefits NHTSA should consider? Please provide data to support views.**

   The offset deformable barrier test described in ECE R94 has carefully chosen test parameters such as speed, extent of offset, and design of the honeycomb fascia. Increasing the test speed without careful consideration can change the nature of the injury producing mechanism and consequently, adversely affect the self-protection afforded to the vehicle occupant. For example, DaimlerChrysler has found that there is very little intrusion in vehicle accidents below 40 km/h (i.e., FMVSS 208 ODB test speed). If the ODB test is run at a speed significantly greater than 56 km/h (or 60 km/h), the resulting increase in vehicle stiffness could potentially lead to an increase in all low-speed injuries (including AIS 2+ leg injuries) for unbelted occupants due to an increase in crash severity.

3. **Is it necessary to stiffen the front corners of vehicles to do well in a fixed offset deformable crash test? Please explain the answer. Also, is the answer to this question different for different vehicle classes? If so, explain the answer for each vehicle class.**

   The "stiffening of the front corners" that the agency has mentioned in the RFC in connection with the high-speed offset deformable test is not clear. Additional clarification by the agency pertaining to this would be necessary in order for us to present a more detailed response. Moreover, the agency has discussed the results of only three cases (Chevrolet Blazer/Trailblazer, Mitsubishi Montero Sport, and Dodge Ram SAE 2004-01-1169) in terms of aggressivity towards cars. Three other cases, which the agency indicated that it would provide the data for during the response period, although they have been included in the docket, don't have accompanying discussions related to aggressivity.

   The main objective in designing the front end of a vehicle that performs well in an offset deformable barrier test such as ECE R94 is to provide a stiffness-homogenous front-end that crushes progressively ahead of a stiff and strong occupant compartment that resists intrusion. Although some design concepts may employ stiff front corners to achieve improvement in activation of the restraint systems, this is not a norm and it doesn't necessarily lead to cars that are more aggressive relative to cars designed based on a full frontal rigid barrier test. In general, heavier cars have stiffer front ends than lighter cars. This is in part a consequence of testing at a fixed speed without an adequate mass restriction. Since mass and test speed are dominant factors influencing self- and partner-protection, they must be considered very carefully in defining a test. Otherwise, the optimal balance between self-protection and partner-protection may not be achieved. This goal could be achieved by using mass-dependent test speed/criteria as described in DaimlerChrysler's general position.

4. **If stiffening the front corners of vehicles to do well in a fixed offset deformable barrier crash test is just one alternative for improving performance, what other types of countermeasures are available to achieve good performance in a fixed offset deformable barrier crash test? What are the costs and required lead-time associated with these countermeasures?**

The response to question No. 3 covers the first part of this question. The costs of countermeasures depend on the lead-time. The earlier the requirements can be integrated in the development process the lower the costs. In the absence of specific test procedures and performance criteria, we cannot provide specific cost estimates.

5. **What are the constraints that vehicle manufacturers must face in designing a vehicle to meet a high speed fixed offset deformable barrier crash test requirement? Which are the most difficult to overcome? What types of vehicles have the most constraints?**

- Balancing the performance between the full frontal rigid barrier test with that in the offset deformable barrier test.

- Balancing self-protection versus partner protection; especially in heavier vehicles.

- The higher the mass, the more critical is the balancing process between self-protection and partner protection.

- Balancing insurance imposed low-speed repair costs against available crush space.

6. **Is it necessary for the agency to consider alternative strategies to prevent vehicles from being too stiff or aggressively designed as a result of a fixed offset deformable barrier crash test requirement?**

The alternative strategies presented by the agency in the RFC are necessary to balance self-protection and partner protection. DaimlerChrysler supports the agency's proposed alternative strategies of either adopting the offset deformable barrier test at mass-dependent speeds or adopting the offset deformable barrier test at a fixed speed with an appropriately chosen mass limit. The latter strategy, as the agency has indicated in the RFC, is an intermediate step to the eventual mass-dependent test speed strategy. It is an attempt to address lower extremity injury protection in a limited way by addressing lighter vehicles while solutions to aggressivity issues related with fixed speed testing of heavier vehicles are still being sought.

7. **Are there certain vehicle classes or vehicle weights that should be exempted from a frontal offset crash test requirement? If so, please state the rationale for each vehicle class exemption or vehicle weight limitation.**

The vehicle weight limitations in offset deformable barrier tests that are run at fixed speeds should be driven by the requirements of balancing self-protection and partner protection in heavier vehicles. As explained in response to question No. 10, the **E**nergy **E**quivalent **S**peed (EES) of 55 km/h against a rigid offset barrier or a 60 km/h against a deformable offset barrier could be adopted. However, these speeds need to be used in conjunction with a vehicle mass limitation in order to be able to balance self- and partner protection in heavy vehicles such as SUVs and LTVs.

8. **This notice discussed one potential alternative strategy establishing an additional performance requirement to limit stiffness and/or energy management. Is this an appropriate strategy to pursue? If so, what requirement should be established?**

From a technological standpoint, DaimlerChrysler supports the agency's option of mass-dependent impact velocity based on definition of the self-protection requirements of the small reference car. DaimlerChrysler also refers the agency to the work of the Alliance of Automotive Manufacturers' Technical Working Group (TWG) on Front-to-Front Compatibility.

9. **Are there other alternative strategies, beyond those mentioned in this notice, which the agency should consider in conjunction with a fixed offset deformable barrier crash test requirement?**

   DaimlerChrysler would like to refer the agency to the on-going work of the Technical Working Group (TWG) on Front-to-Front Compatibility, a part of the Alliance of Automotive Manufacturers.

10. **What optimum test speed should be employed in the fixed offset deformable barrier test so as to maximize occupant compartment integrity and at the same time ensure no undue stiffening of the fronts of large vehicles? What are the trade-offs between test speed and front-end stiffness of vehicles? Are the countermeasures dependent upon the test speed? If so, please explain the dependence.**

    DaimlerChrysler's study [6] shows that about 90% of offset crashes that are associated with AIS2+ injuries occur at speeds up to and including 55 km/h EES. This corresponds to an offset rigid barrier crash test speed of 55km/h. Due to the energy absorbed by the deformable fascia, the test speed of 60km/h for a mid-size car in an offset deformable barrier test would represent nearly the same crash severity as a 55km/h test speed in a rigid barrier test [2,3,5,6,]. Therefore an offset test speed up to about 60km/h represents most of real world accident severities with injured occupants. However, such a test speed could lead to partner protection issues in heavier vehicles such as SUVs and LTVs, and consequently an appropriate mass restriction in needed.

Proposed Research Directions:

1. The agency's benefits analysis, submitted to the docket, is based on a small, non-uniform sample of test data. The details of how the agency derived the bounds on the injuries reduced cannot be gleaned from the agency's submission. Moreover, as the agency has mentioned in the submission, the disbenefits to the belted and the unbelted occupants due to potential vehicle stiffness increase from ODB testing at speeds much greater than 56 km/h, is not included. In other words, the agency's benefits analysis in the docket is incomplete. Although, convincing benefits analyses pertaining to the European fleet are available, the conclusions from those studies may not apply to the US fleet due to differences in mass distribution between the fleets and considerable unbelted occupants in the US. Consequently, we recommend that the agency carry out a more exhaustive benefits analysis including disbenefits from potential stiffness increase and consideration of unbelted occupants, based on a reasonably large and uniform sample of test data.

2. The agency's research shows that in rigid barrier testing (NCAP) and ODB testing (IIHS) the lower extremity assessment numbers exceed the IARVs nearly equally frequently. The agency's accident data analysis should attempt to identify the proportion of lower extremity injuries that could be addressed by an ODB test and the proportion of lower extremity injuries that could be addressed by a rigid barrier test.

3. The agency's research on front-to-front compatibility is in progress. So is the research being conducted by the auto companies on front-to-front crash-compatibility. This research needs to attain some level of maturity before its conflicting requirements with that of an ODB test can be understood. Consequently, any research in the area of ODB testing should consider the progress in the arena of front-to-front compatibility closely.

4. From a technological standpoint, the agency's option of mass-dependent impact velocity based on definition of the self-protection requirements of the small reference car, appear to be logical. The agency should research this option in detail along with an associated benefits analysis in order to assess the impact on self-protection as well as partner protection.

5. The vehicle weight limitations in offset deformable barrier tests that are run at fixed speeds should be driven by the requirements of balancing self-protection and partner protection in heavier vehicles. The **E**nergy **E**quivalent **S**peed (EES) of 55 km/h against a rigid offset barrier or a 60 km/h against a deformable offset barrier could be adopted. Studies show that about 90% of offset crashes that are associated with AIS2+ injuries occur at speeds up to and including 55 km/h EES. This corresponds to an offset rigid barrier crash test speed of 55km/h. Due to the energy absorbed by the deformable fascia, the test speed of 60km/h for a mid-size car in an offset deformable barrier test would represent nearly the same crash severity as a 55km/h test speed in a rigid barrier test. Therefore an offset test speed up to about 60km/h represents most of the real world accident severities with injured occupants. However, such a test speed could lead to partner protection issues in heavier vehicles such as SUVs and LTVs, and consequently an appropriate mass restriction in needed. The agency should undertake research to estimate the impact of mass restrictions on the fleet in terms of self-protection and partner-protection.

6. There is an adequate level of experience in the industry in the usage of Denton lower extremity instrumentation in frontal crash tests. There is a very limited level of experience with the Thor Lx instrumentation. This situation could be remedied if the agency could conduct substantial research pertaining to repeatability, reproducibility, durability, and ease of use of Thor Lx in rigid barrier and ODB tests. This research would supplement DaimlerChrysler's position that the two lower extremity instruments should be available as alternates for some years before a decision to use one or another is made.

7. The injury assessment limits for the Denton lower extremity instrumentation are based on earlier cadaver data. The injury assessment limits for Thor Lx are based on more recent cadaver data. Moreover, the assessment values are not equivalent due to design differences between the two instrumented extremities. The agency should conduct research aimed at shedding more light on the impact of these differences on crash tests, as well as developing equivalent injury criteria for the two instrumented extremities.

References:

[1] K.-H. Baumann, L. Groesch, H. Holtze, W. Schwede: **"Frontal Offset Crash testing for Approx. 15 Years: Results, Experience and Consequences"** SAE paper No. 90-0413

[2] B. Pletschen, R. Herrmann, I. Kallina, F. Zeidler: **"The Significance of Frontal Offset Collisions in Real World Accidents"** SAE paper No. 90-0411

[3] I. Kallina, F. Zeidler, K.-H. Baumann, D. Scheunert: **"The Offset Crash Against a Deformable Barrier, a More Realistic Frontal"** ESV-Conference 1994, Munich, Germany

[4] I. Kallina, D. Scheunert, J. Scheerer, R. Breitner, F. Zeidler: **"Injuries of the Lower Leg-Significance for the Occupants-Assessment in Tests - Injury Prevention"** International Conference on Pelvic and Lower Extremity Injuries, December 4-6, 1995, Washington, D.C., pp. 211-218

[5] D. Scheunert, R. Justen, R. Herrmann, F.Zeidler, J. Decker, I. Kallina: **"What is a Realistic Frontal-Offset Test Procedure?"** Accident Analysis and Prevention, Vol. 26, No. 3, pp. 347-360, 1994

[6] F. Zeidler, F. Knöchelmann, **"The Influence of Frontal Crash Test Speeds on the Compatibility of Passenger Cars in Real World Accidents"** International Journal of Crashworthiness, Vol. 3, No.1, 1998

[7] DaimlerChrysler Response to Advanced Notice of Proposed Rulemaking: Anthropomorphic Test Devices; Instrumented Legs for Hybrid III – 50M and Hybrid III – 5F Dummies **(Docket No. NHTSA 2002-11838-8)**